Instruments Pitch Comparison

Midterm1 Assignment3 – Giacomo Carfì -520951

1 Instruments and notes selection

By printing the instruments for each note on the screen, it is possible to find which instruments play the same note with the same dynamics and octave.

Some notes and their instruments are shown.

```
Gs5_15_forte_normal.mp3 ['flute', 'clarinet', 'trombone', 'oboe', 'saxophone', 'trumpet']
D5_025_forte_normal.mp3 ['flute', 'bassoon', 'clarinet', 'trombone', 'oboe', 'trumpet']
Gs5_05_forte_normal.mp3 ['flute', 'clarinet', 'trombone', 'oboe', 'saxophone', 'trumpet']
Ds5_15_forte_normal.mp3 ['flute', 'clarinet', 'trombone', 'oboe', 'saxophone', 'trumpet']
C5_025_piano_normal.mp3 ['flute', 'bassoon', 'clarinet', 'trombone', 'saxophone']
C4_05_forte_normal.mp3 ['flute', 'bassoon', 'clarinet', 'contrabassoon', 'trombone', 'tuba', 'oboe', 'saxophone', 'trumpet']
F6_1_forte_normal.mp3 ['flute', 'clarinet', 'oboe', 'saxophone']
Gs4_1_mezzo-forte_normal.mp3 ['flute', 'bassoon', 'trombone', 'oboe']
C4_025_pianissimo_normal.mp3 ['flute', 'clarinet', 'tuba', 'saxophone', 'trumpet']
D4_05_pianissimo_normal.mp3 ['flute', 'clarinet', 'trombone', 'tuba', 'saxophone', 'trumpet']
```

1 Instruments and notes selection

Let's focus the experiments on just a few of them

Notes

1. D5_025_forte_normal
2. C4_05_forte_normal
3. B4_15_forte_normal
4. A4_025_piano_normal

Instruments

1. Flute
2. Clarinet
3. Trombone
4. Oboe

2 Experiments

For each note and each instrument, the frequency of the fundamental note f0 is identified using probabilistic YIN algorithm.

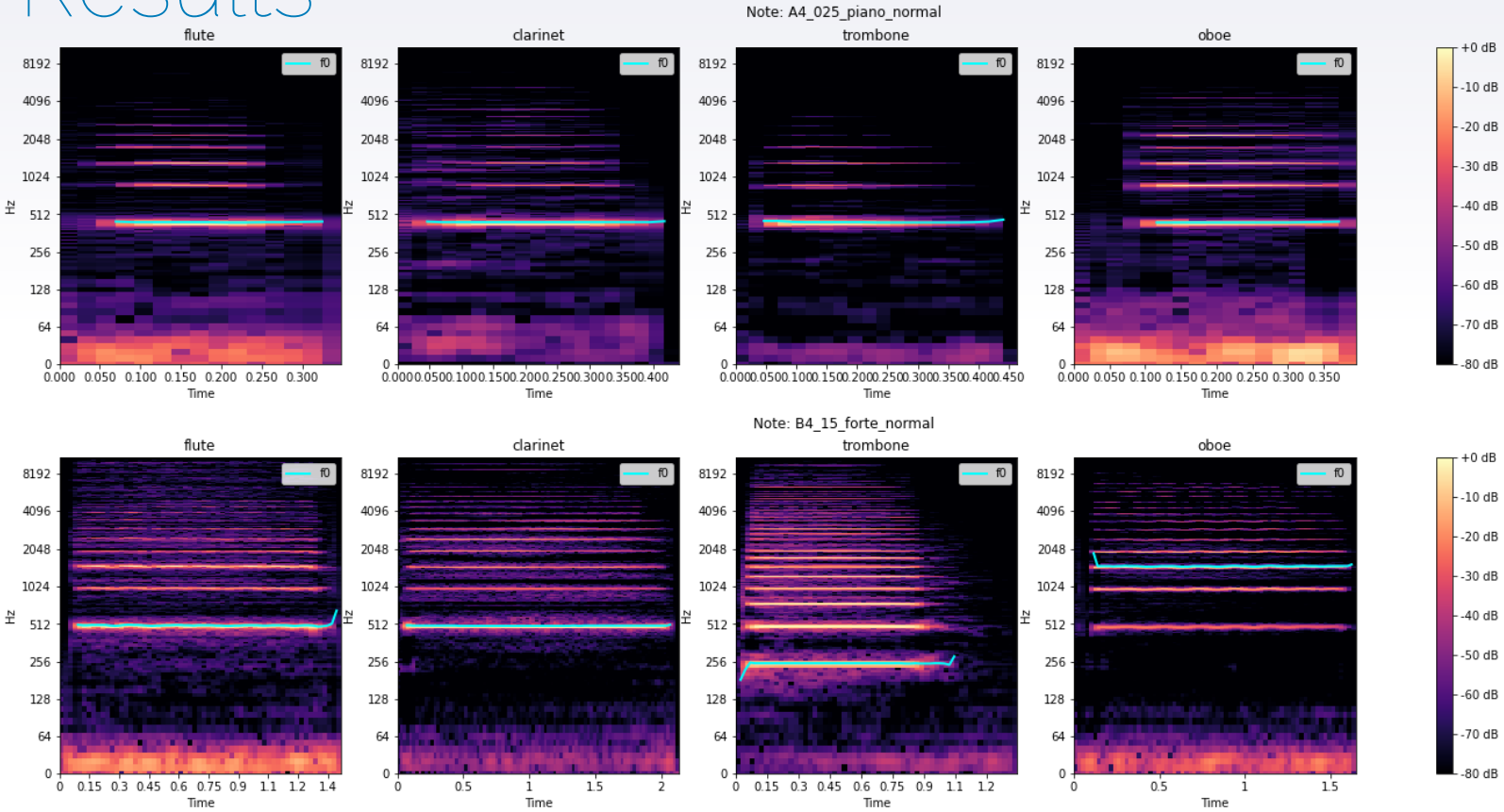
The short-time Fourier transform method is used to analyze time series in the frequency domain.

The decomposition of the sound into harmonic and percussive is performed, focusing only on the harmonic part of the sound.

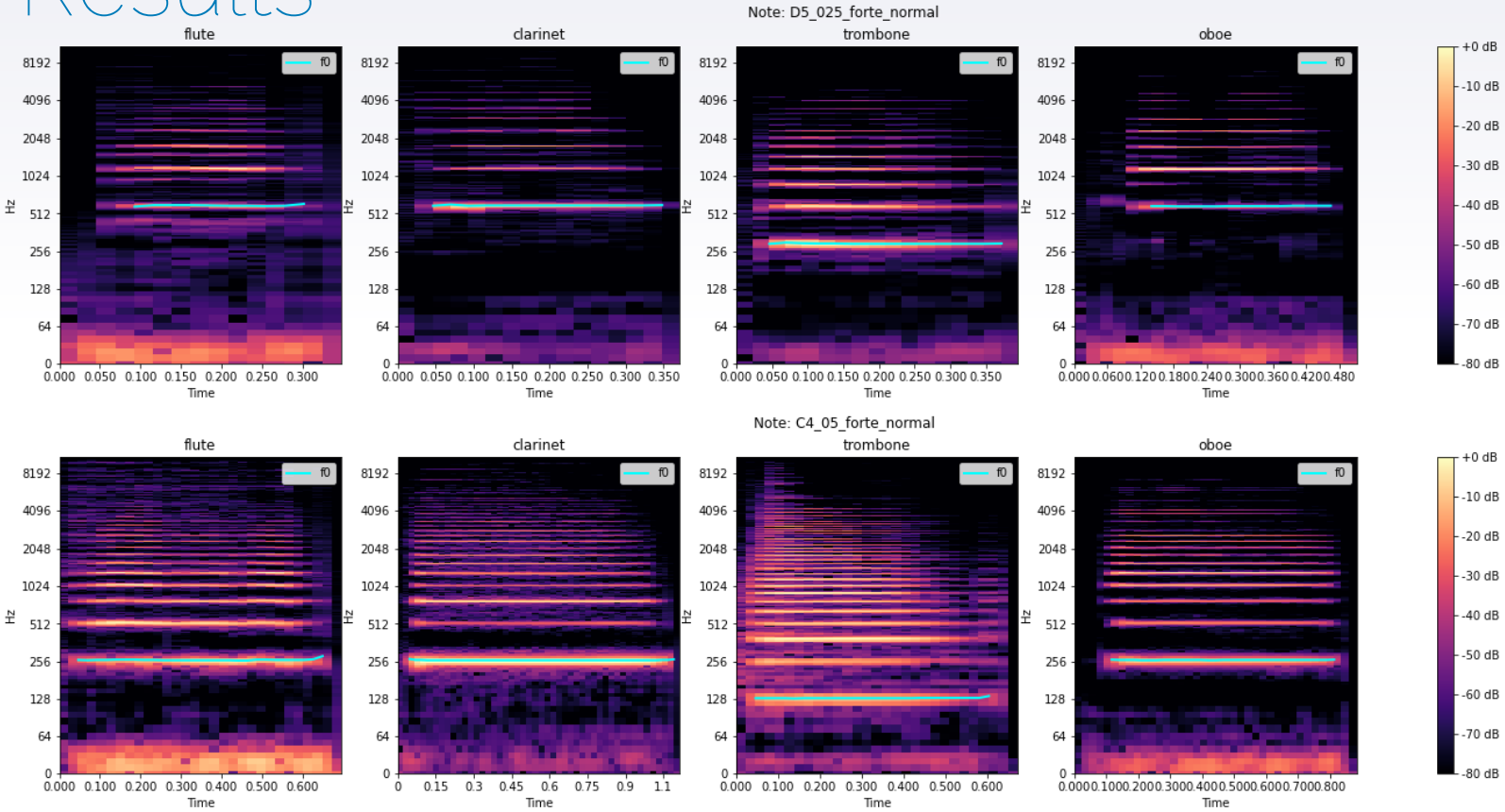
The power spectrum is then plotted in order to analyze the differences between the instruments.

```
y, sr = librosa.load(path)

# fundamental note
f0, voiced_flag, voiced_probs = librosa.pyin(y,
                                             fmin=librosa.note_to_hz('C2'),
                                             fmax=librosa.note_to_hz('C7'))
times = librosa.times_like(f0)

# STFT of y
D = np.abs(librosa.stft(y))

# harmonic decomposition
H, P = librosa.decompose.hpss(D)

power = librosa.power_to_db(H**2, ref=np.max)


img = librosa.display.specshow(power,
                               y_axis='log', x_axis='time', ax=ax[index])


ax[index].plot(times, f0, label='f0', color='cyan', linewidth=2)
ax[index].legend(loc='upper right')
```

3 Results


Note: A4_025_piano_normal
flute
clarinet
trombone
oboe
f0
Hz
Time
+0 dB
-10 dB
-20 dB
-30 dB
-40 dB
-50 dB
-60 dB
-70 dB
-80 dB
Note: B4_15_forte_normal
flute
clarinet
trombone
oboe
f0
Hz
Time

3 Results


Note: D5_025_forte_normal
flute
clarinet
trombone
oboe
f0
Hz
Time
+0 dB
-10 dB
-20 dB
-30 dB
-40 dB
-50 dB
-60 dB
-70 dB
-80 dB
Note: C4_05_forte_normal
flute
clarinet
trombone
oboe
f0
Hz
Time

4 Conclusions

1. As can be seen from the spectrograms, the oboe and the flute in comparison to the other instruments seem to be characterized by a strong presence of low frequencies.
2. Compared to the other instruments, the trombone presents more low-mid frequencies, while the clarinet in some notes, shows higher frequencies than the trombone.
3. It is also possible to notice that the frequency of the fundamental note in the trombone is lower than in the other instruments.